CLAIMS

What is claimed is:

1. A method of monitoring radio frequency interference (RFI) in a satellite signal, wherein the satellite signal includes a carrier signal, the method comprising:

calculating a statistical variance estimate (V) based on a plurality (K) of discriminator values (d_k) formed in a carrier tracking loop; and

calculating an RFI detector from the statistical variance estimate.

2. The method of claim 1, wherein the statistical variance estimate is calculated in the form of:

$V = c \cdot \frac{1}{K-1} \sum_{k=1}^{K} d_k^2$, wherein k is an index value from 1 to K and c is a scaling constant.

3. The method of claim 1, wherein the statistical variance estimate is calculated in the form of:

$V = c \cdot \frac{1}{K} \sum_{k=1}^{K} d_k^2$, wherein k is an index value from 1 to K and c is a scaling constant.

4. The method of claim 1, wherein the RFI comprises continuous wave RFI.

5. The method of claim 1, wherein the RFI comprises narrowband RFI.

6. The method of claim 1, wherein the RFI comprises continuous wave RFI and

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narrowband RFI.

7. The method of claim 1, wherein the carrier tracking loop comprises a phase-locked loop.

8. The method of claim 7, wherein the phase-locked loop is a Costas loop.

9. The method of claim 1, wherein the carrier tracking loop comprises a frequency-locked loop.

10. The method of claim 1, wherein the carrier tracking loop comprises a phase locked loop and a frequency-locked loop.

11. The method of claim 10, wherein the carrier tracking loop has a first mode of operation and a second mode of operation, wherein the first mode of operation is a phase-locked operation and the second mode of operation is a frequency locked operation, and wherein a first RFI detector is formed when the loop operates in the first mode and a second RFI detector is formed when the loop operates in the second mode.

12. The method of claim 1, wherein the RFI detector is defined as a root-mean-square (RMS) of the discriminator value.

13. The method of claim 1, wherein the RFI detector is derived from a square root value of the statistical variance estimate.

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14. The method of claim 1, wherein each of the plurality of the discriminator values is formed at a periodic interval.

15. The method of claim 14, wherein the periodic interval is .01 seconds.

16. The method of claim 1, wherein K is 100.

17. The method of claim 1, wherein each of the plurality of the discriminator values is formed from in-phase and quadrature-phase components of the satellite signal.

18. The method of claim 1, further comprising determining whether a loss of lock of the carrier tracking loop has occurred by determining whether the RFI detector exceeds a threshold value.

19. The method of claim 18, wherein the threshold value is determined by simulating a response of the carrier tracking loop to CW and narrowband RFI.

20. The method of claim 19, wherein the threshold value is .6 radians.

21. The method of claim 18, wherein the threshold value is adjusted based on a signal-to-noise ratio of the satellite signal.

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22. The method of claim 1, further comprising determining whether a cycle slip of the carrier tracking loop has occurred by determining whether the RFI detector exceeds a threshold value.

23. The method of claim 22, wherein the threshold value is determined by simulating a response of the carrier tracking loop to CW and narrowband RFI.

24. The method of claim 23, wherein the threshold value is .6 radians.

25. The method of claim 22, wherein the threshold value is adjusted based on a signal-to-noise ratio of the satellite signal.

26. The method of claim 1, wherein the carrier tracking loop is implemented in a receiver.

27. The method of claim 26, wherein the receiver comprises a plurality of tracking channels, each tracking channel for tracking one satellite signal, and wherein the RFI detector is calculated for each of the plurality of tracking channels.

28. The method of claim 1, wherein the satellite signal is selected from the group consisting of a GPS, GLONASS, Galileo, WAAS, and EGNOS signal.

29. The method of claim 1, embodied as machine language instructions stored on a

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machine-readable medium.

30. The method of claim 29, wherein the machine-readable medium is a data storage element readable by a microprocessor.

31. The method of claim 1, wherein the RFI is present in a pass band of the carrier signal.

32. The method of claim 31, wherein the RFI is present in a pass band of the carrier tracking loop.

33. A method of monitoring narrowband and continuous wave RF interference in a system comprising a plurality of satellites transmitting a respective plurality of satellite signals, at least one reference receiver and a ground station, wherein the at least one reference receiver receives the satellite signals from the plurality of satellites, the method comprising:

forming, for each satellite signal, a plurality of discriminator values (d_k) based on processing, in a carrier tracking loop included within one of the at least one of reference receivers, a carrier signal associated with the satellite signal;

calculating a statistical variance estimate (V) for each satellite signal based on the plurality (K) of discriminator values (d_k); and

calculating an RFI detector from the statistical variance estimate.

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34. The method of claim 33, wherein the statistical variance estimate is calculated in the form of:

$V = c \cdot \frac{1}{K-1} \sum_{k=1}^{K} d_k^2$, wherein k is an index value from 1 to K and c is a scaling constant.

35. The method of claim 33, wherein the statistical variance estimate is calculated in the form of:

$V = c \cdot \frac{1}{K} \sum_{k=1}^{K} d_k^2$, wherein k is an index value from 1 to K and c is a scaling constant.

36. The method of claim 33, wherein the step of calculating the RFI detector is carried out in the at least one reference receiver.

37. The method of claim 36, wherein the at least one reference receiver measures a pseudorange for each received satellite signal and transmits the RFI detector to the ground station along with the pseudorange, and wherein the ground station calculates differential corrections using the pseudorange transmitted from the at least one reference receiver.

38. The method of claim 37, wherein the ground station compares the RFI detector to a threshold value and excludes the pseudorange from the differential calculations if the RFI detector exceeds the threshold value.

39. The method of claim 38, wherein the threshold value is indicative of a loss of lock of the carrier tracking loop of the at least one reference receiver.

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40. The method of claim 38, wherein the threshold value is indicative of a cycle slip of the carrier tracking loop of the at least one reference receiver.

41. The method of claim 33, wherein the step of calculating the RFI detector is carried out in the ground station.

42. The method of claim 33, further comprising:

storing the RFI detector in a data storage element of the ground station; and

quantifying the levels of the CW and the narrowband RF interference present in the ground station by evaluating a time history of the RFI detector over the plurality of satellites.

43. The method of claim 33, wherein the system is selected from the group consisting of LAAS, WAAS, and EGNOS.

44. A method for monitoring continuous wave and narrowband interference in a pass band of a satellite carrier signal, the method comprising in combination:

means for estimating a statistical variance among a plurality of discriminator values formed in a tracking loop, wherein the tracking loop tracks the satellite carrier signal;

means for calculating a standard deviation value from the statistical variance estimate;

means for comparing the standard deviation value to a threshold value; and

means for detecting an RFI fault when the standard deviation value exceeds the threshold value.

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